

Technical Report 481

12

# ORGANIZATIONAL STRUCTURE AND LEADERSHIP FACTORS AS DETERMINANTS OF SMALL GROUP PERFORMANCE

Alan H. Harris  
The John Hopkins University School of Medicine

PERSONNEL UTILIZATION TECHNICAL AREA

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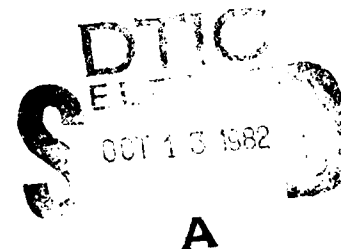


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June 1980

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earn money for either themselves individually or through group effort chose to distribute their work performance under conditions where a group effort was most efficient to protect accumulated earnings from possible loss.

With regard to motivational control, the unexpected outcome of these experiments was that daily earnings were relatively stable and insensitive to changes in the form of earnings (i.e., individual vs. group bank accounts). Our current hypothesis regarding this outcome is that the effects of such motivational systems are directly influenced by the temporal distribution of daily work and nonwork activities. That is, if the nature of a task is such that hourly segments of work-nonwork cycles naturally occur, then a motivational system (e.g., individual vs. group) available on the same temporal scale will be relatively more effective than one which is much longer than the natural alteration of work and nonwork behaviors.

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**Technical Report 481**

# **ORGANIZATIONAL STRUCTURE AND LEADERSHIP FACTORS AS DETERMINANTS OF SMALL GROUP PERFORMANCE**

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## FOREWORD

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This Technical Report, "Organizational Structure and Leadership Factors as Determinants of Small Group Performance," describes research by Alan Harris from the Johns Hopkins University School of Medicine under Army Project Number 2Q161101B74F.

The major developmental effort in this area of research so far has been in establishing a biofeedback system for the autonomic self-regulation task. However, this research was concerned with conducting experiments which focused on motivational and organizational variables influencing group and individual performance, social interactions, and morale.

Special thanks go to ARI's Personnel Utilization Technical Area for the assistance with the research and to George Lawton for acting as this project's COR.

  
JOSEPH ZEIDNER  
Technical Director

ORGANIZATIONAL STRUCTURE AND LEADERSHIP FACTORS AS DETERMINANTS  
OF SMALL GROUP PERFORMANCE

BRIEF

Requirement:

A need exists to learn how to best arrange individual and/or group living and work routines in order to promote maximum performance effectiveness and maintain high morale throughout a mission's duration. Where sustained and accurate performance of personnel on a complex duty assignment for long periods is critical to the success of the mission, it is essential to have the most effective organizational structure possible. It is also necessary to study the leadership factors which determine performance over extended intervals and the day-to-day status of a group as a social system.

Procedure:

Groups of carefully screened male and female volunteers between the ages of 18 and 35 years were recruited from the Baltimore-Washington area for participation. Each participant was placed in a private room with an intercom connection to the other participants.

The experiments had the objective of determining how human subjects chose to work when given the opportunity to earn money for themselves either individually or through group effort.

The experiments involved three men or three women living in the experimental environment for 10 consecutive days. In order to investigate the control exercised by individual versus group pay systems, various days of the experiment were designated as one or the other and monies earned went into the appropriate account.

The final experiment was concerned with determining the effects of imposed triadic work conditions upon performance effectiveness, social interaction, and morale.

Findings:

The findings from the first experiment were: (1) Over 48 consecutive hour intervals under avoidance contingencies three-person groups of male and female subjects cooperated in maintaining a continuous watch of a monitor display and correctly reported all interruptions of the programmed task. (2) The cooperative monitoring performance was characterized by a rotating schedule of "on-duty" responsibility of 3 to 4 hours for the men and 2 to 3 hours for the women. (3) When given a choice, 3/3 men and 1/3 women chose



to work significantly more for individual earnings as compared to working in a shared group effort.

With regard to motivational control, the unexpected outcome of the second experiment was that daily earnings were relatively stable and insensitive to changes in the form of earnings (i.e., individual versus group bank accounts). The data from these experiments suggest that conformity to a rule depends not only upon the nature of the rule itself, but also upon its temporal parameters and the extent to which these parameters match or correspond to the temporal size of everyday work and rest activities.

The results of the third experiment showed that individual contributions to the group account were not equally distributed among the three participants. Despite this inequity, the group maintained good social relations and achieved the maximum allowable earnings on 7 of the 10 days including the last 6 days in a row.

#### Utilization of Findings:

It can be seen by the first experiment that the relative uncertainty of group performance makes the three individuals involved tend to concentrate on earning money for themselves. This can be seen as self-interested performance. In the second experiment, the three did not work significantly more for their individual earnings. Taken together, the data from these experiments suggest a sensitive procedure for revealing self-interest versus group-oriented behavior in a residential laboratory setting.

ORGANIZATIONAL STRUCTURE AND LEADERSHIP FACTORS AS DETERMINANTS  
OF SMALL GROUP PERFORMANCE

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# ORGANIZATIONAL STRUCTURE AND LEADERSHIP FACTORS AS DETERMINANTS OF SMALL GROUP PERFORMANCE

## BACKGROUND

Where sustained and accurate performance on a complex duty assignment for days, weeks, or longer is critical to the successful outcome of a given mission, it is obviously essential to know how best to arrange individual and/or group living and work routines to promote maximum performance effectiveness and maintain high morale throughout the mission's duration. It is thus necessary to know the most effective organizational structure for such operational units and to understand the interacting leadership factors which in concert determine both performance maintenance over extended intervals and the day-to-day status of the group as a social system.

For the most part, the voluminous research literature on organizational structure and leadership which has developed over the past two decades (for reviews see Shaw, 1971, Hare, 1976) is characterized by one or the other of two investigative restraints which limit the generality of experimental findings. On the one hand, studies which have focused upon ongoing operational settings (e.g., industrial and/or military groups) in the natural ecology have been limited by the lack of control which can be exercised for the purpose of manipulating critical experimental variables. On the other hand, laboratory situations which offer the opportunity for required experimental manipulations have seldom provided for extended residential intervals of observation and objective recording under realistic and naturalistic incentive conditions for a broad spectrum evaluation of performance effectiveness and morale in small operational groups. The continuously programmed residential environment approach represents an attempt to circumvent these evident limitations on organizational structure and leadership research with small groups.

The aims of the proposed studies are to investigate the effects upon individual and small group performance (i.e., cognitive functions, physical work, and biofeedback-assisted autonomic self-regulation) effectiveness by variations in organizational structure, leadership, and motivational conditions. Differing degrees of constraint will be imposed upon the distribution and duration of duty assignments under the control of either selected individuals within the group or designated "command" external to the group. Duty assignments will be maintained either cooperatively on the basis of rewards for interdependent work activity by members of the group or competitively maintained on the basis of individual achievement.

## METHODS AND PROCEDURES

### Subjects

Groups of male and female volunteers between the ages of 18 and 35 years were recruited from the local community (i.e., Baltimore-Washington area) for participation in the proposed studies. Provisions can also be made for accommodating other special populations (e.g., military groups) in order to

address specific experimental questions related to selected group characteristics (e.g., mixed racial or gender combinations, etc.). All subjects were required to undergo careful psychological, psychiatric, and medical screening before acceptance as study participants to minimize risk of harm. In addition, extended pre-experimental try-out sessions were conducted with all participants to insure that they are fully cognizant of the experimental objectives and procedures. A manual of instructions detailing the operational features of the environment and the specific performance requirements of the experiment in question was provided for the permanent retention of each participant for continual guidance and whatever reference purposes may seem necessary or desirable before, during, and after the experiment. Finally, written informed consent was obtained from each subject detailing the right to withdraw from the experiment at any time without prejudice in accordance with the procedures reviewed and approved by the Johns Hopkins University School of Medicine Committee on Clinical Investigation. This institutional human subjects research review committee operates under General Assurance Agreement Number 0174 with the U.S. Department of Health, Education, and Welfare.

For the specific purposes of the research described in the present proposal, additional test instruments were included with the existing pre-experimental screening battery to provide measures of Locus of Control (Rotter, 1954), Sixteen Personality Factor Questionnaire (Cattell, 1957), and Personal Attributes and Social Behavior Inventory (Helmreich & Stapp, 1974). These self-rating measures may correlate with the individual and group performance and morale effects observed and recorded in the course of the study with a view to identifying predictor variables for optimizing unit training and organizational effectiveness.

### Apparatus

The programmed environment, as shown schematically in Figure 1 below, is composed of three 8.5 x 11 x 8 ft. private living rooms, a 14 x 22 x 9 ft. recreation room, a 8.5 x 13.5 x 9 ft. workshop, and a 7.5 x 26 x 8 ft. hall joining the rooms. Each private room is similar to a small efficiency apartment containing bathroom, bed, desk, kitchen, and other furnishings. The recreation room contains table, chairs, and sofas. A complete kitchen facility is located there, and a storage cabinet contains solitary, dyadic, and triadic games. The workshop contains washer and dryer, workbench, tools, and storage compartments for hobby projects and supplies. All rooms contain two-way storage compartments accessible from the periphery of the environment in which meals and other materials can be delivered to subjects. A common bathroom serves the recreation room and the workshop. An intercom for dyadic and triadic conversations among subjects is mounted on a work panel in each private room, and remotely controlled door locks regulate subject movement between rooms within the environment. Each room, however, contains a full-sized unlocked emergency exit door which can be used to terminate the experiment at any time. The electromechanical control devices throughout the environment are interfaced with a computer system located in an adjoining laboratory support facility which provides for experimental monitoring, programming, recording, and data analysis. The computer is linked to a Cathode Ray Tube (CRT) Display Device within each of the private

rooms of the residential laboratory, and an alpha-numeric keyboard with each display unit provides for direct communication with the system control. A communication panel in each individual chamber includes a telephone intercom for exchanges between subjects within the environment, and audio and video equipment in each of the residential chambers permits continuous monitoring during conduct of an experiment.

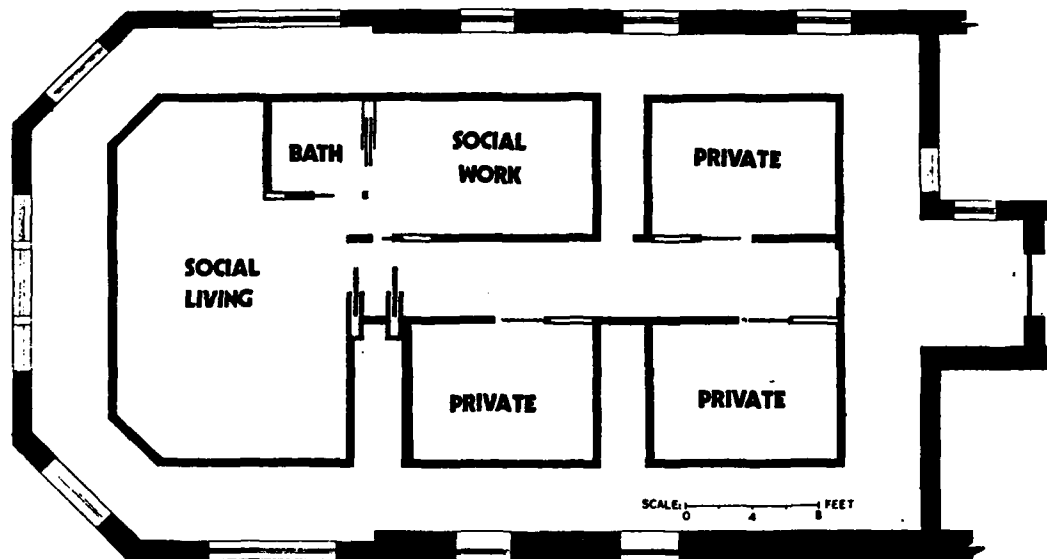


Figure 1. Schematics of the programmed environment.

#### Behavioral Programming Procedures

Figure 2 presents a diagrammatic representation of a typical behavioral program governing the sequential and contingent relationships of activities to be employed, in general form, throughout the proposed series of experiments. Each box within the diagram represents a distinct behavioral unit and response requirement. Subjects progress through the program sequentially from left to right. This progression involves program branches composed of a fixed activity sequence and optional activity sequences. Regardless of the sequence selected, the diagram indicates that all behavioral units are scheduled on a contingent basis such that access to a succeeding activity demands satisfaction of the requirements for the preceding unit.

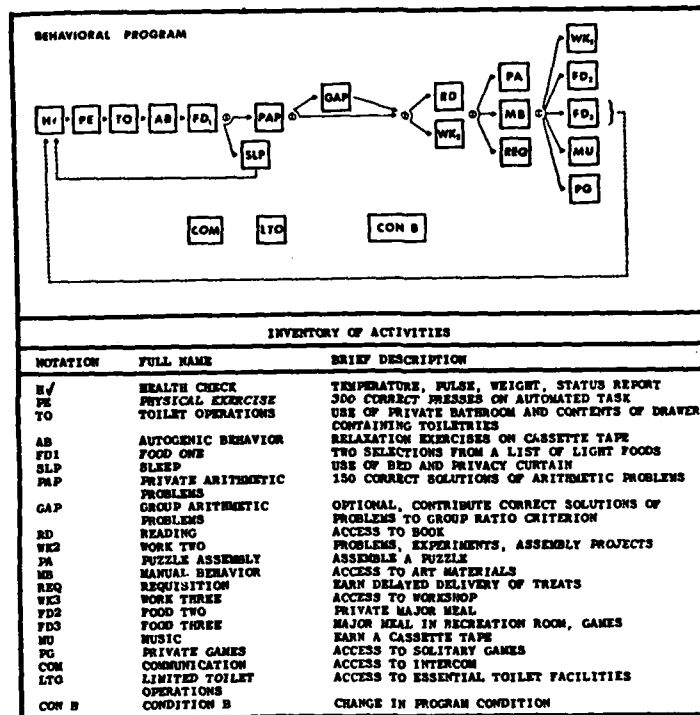


Figure 2. Diagrammatic representation of a typical behavioral program.

#### Specific Duty Assignment Work Tasks

The experiment on organizational structure and leadership factors as determinants of small group performance effectiveness and morale involve three separate work tasks available for duty assignments during continuous residence within the context of the behaviorally programmed environment. The three tasks differ in the extent to which they require "cognitive" activity (Multiple Task Performance Battery), physical exertion (Exercise), and control of physiological processes (Biofeedback), though each can be programmed for individual performance within the private chambers or under group conditions in the social workshop area.

(1) The Multiple Task Performance Battery (MTPB) is a modified version of a performance battery composed of five component tasks used in previous small group research (Morgan & Alluisi, 1972). The first watchkeeping component requires the operator to monitor a blinking light which changes position between two vertically arrayed displays at a baseline rate of twice per second. When the light becomes fixed and flashes repeatedly in either vertical position without changing, the operator is required to make a response which restores the signal to baseline conditions. The second vigilance component of the MTPB requires the operator to monitor two vertically arrayed displays for a change in baseline condition when a green light is extinguished

in one display and a red light is illuminated in the second display. The operator is required to make a response which extinguishes the red light and re-illuminates the green light. The third probability monitoring component of the MTPB provides a measure of attentive functioning. On each of four separate and independent scales, a pointer exchanges position in such a way that the average scale value is the mid-scale position. At random intervals, a bias occurs such that the average pointer value, over time, is either to the left or to the right of the mid-scale position. A response by the operator while a bias is present restores the average pointer value to the mid-scale position. The fourth target identification component of the MTPB provides a measure of sensory-perceptual functions. An original histogram is presented within a 6 x 6 element matrix with its base at 6 o'clock and with no bar lengths repeated. The original histogram is erased, and two matching histograms are presented successively. The matching histograms appear with bases at 9 o'clock, 12 o'clock, or 3 o'clock. One of the matching histograms may or may not duplicate the original "target" histogram. The operator indicates whether the first, second, or neither of the matching histograms was identical to the origin target. The fifth mathematical operations component of the MTPB provides a measure of short-term and long-term memory functions. The solution requires summing the first two numbers and subtracting the third from the sum.

(2) The Physical Exercise Task (PET) requires the subject to reach and press switches located in four positions (two high--left and right; two low--left and right) on one wall of the environmental chamber. Lights above the switch in each location indicate which switch is to be pressed. The mixed order of light sequences right and left, up and down, produces a rhythmic calisthenic type exercise behavior. Satisfactory PET performance requires that the illuminated switch be pressed within 0.5 seconds of illumination.

(3) The Biofeedback Self-Control Task (BSCT) is based upon the rapidly expanding experimental and clinical literature describing the use of instrumental or operant conditioning techniques for the regulation of physiological processes (Kamiya, Barber, Miller, Shapiro, & Stoyva, 1977). In the course of these increasingly more visible empirical developments, methodological and theoretical concerns with mediational events, response specificity, and therapeutic efficacy have provided the occasion for evaluating the potential interactions between operant cardiovascular effects and physiological stress concomitants such as respiration and electromyographic activity, among others (Katkin & Murray, 1968; Obrist, Webb, Sutterer, & Howard, 1970; Black, 1971; and Birk, 1973). Little or no attention, however, has been directed to the relationships between states of instrumentally regulated responses and concurrently maintained behavioral task performance. The BSCT will provide the subject with auditory and/or visual feedback signals through the mediation of standard physiological transducer instrumentation in relationship to self-generated changes in heart rate, skin temperature, and forehead muscle tension. Satisfactory BSCT performance requires attainment of criterion levels and durations of physiological values in relationship to initial baseline determinations under varying organizational structure and leadership conditions.



## RESULTS

The accomplishments during this first year of our research contract have been both substantive and methodological. Major pieces of equipment have been purchased and integrated into the development of work tasks and biofeedback-assisted temperature self-regulation. Following the "tooling up" phase of our work, experiments were conducted which focused upon motivational and organizational variables influencing group and individual performance, social interactions, and morale.

### Methodological and Technical Developments

The cognitive function tasks (i.e., Alluisi Performance Battery and repeated serial acquisition) are fully developed and currently operational for experimental protocols. The physical work tasks currently available involve simple calisthenic exercise and lever pulling with plans for the development of more precise measurement and control of physical work through the use of an exercise ergometer. For this purpose, a Collins Model 07605 Pedalmate Two Ergometer and a Collins Model 07610 Total Work Integrator have been requested and approved for purchase and incorporation into the programmed laboratory performance system. This unit has recently been received and tested in our laboratory. Subsequent experiments will involve the use of this instrument to provide calibrated control of work loads ranging from 25 to 400 watts.

Biofeedback Instrumentation. The major developmental effort thus far has been in establishing a biofeedback system for the autonomic self-regulation task. In design and engineering our own hybrid feedback system, we are developing a computerized state-of-the-art instrument to provide a standard of flexibility and resolution and incorporate a significant number of training-oriented features not found on commercial feedback systems. The most significant characteristic of the temperature feedback system is the high resolution and accurate registration of minute temperature changes on the order of one-tenth of a degree. The instrumentation system being developed has the ability to vividly display and process small subtle temperature shifts as to accurately register and clearly inform the subject of his on-going temperature changes.

A 25" color-graphics video terminal (ICS Model 8001 GB) is being used as the main vehicle for the visual feedback display. Integrated into an existing physiological monitoring system, this multi-colored CRT display terminal is programmed to generate a high resolution bar-graph matrix feedback display of the temperature function. The physiological system consists of an Intel 80/10 microcomputer and a DEC LA-36 data printer subsystem supported by various self-contained biofeedback devices for monitoring temperature, EMG, skin conductance, and heart rate variables. These additional physiological variables will be used to accurately evaluate and correlate the temperature function with other voluntary and involuntary body processes.

To accurately register the on-going temperature changes, a large 1-inch-wide horizontal "red" bar is generated onto the screen of the color display in direct view of the subject. The subject's temperature reading is updated

once per second and is graphically scaled to indicate one-tenth degree markings along the "Y" axis of the display. In addition to the red temperature bar, a bright yellow criterion or target identification bar graph is displayed directly under the temperature graph. The scaling of the criterion graph is automatically computed and updated each minute by the microcomputer to project a new target value to the subject. If the subject fails to reach the target value with a 1-minute epoch, the target value will remain unchanged. However, if the subject reaches or surpasses the target value, the computer will automatically assign a new criterion value of one-half degree larger than the previous criterion level.

In addition to the red temperature and yellow target bar graphs, the system also provides a purple achievement bar. This third bar represents the total achievement effort of the subject during the entire feedback session.

In conjunction with the bar-graph displays, an additional visual feedback feature of the system is the presentation of all information in digital form on the display screen. The on-going functions of temperature, criterion level, and achievement time are continually updated and numerically registered on the screen in corresponding colored values.

The final operation of the feedback system is the listing of all data on the printer terminal. One-minute averages of the physiological variables (EMG, SC, heart rate) along with the biofeedback values of temperature, criterion value, and achievement are listed to provide an easily discernible pictorial of the interactions and correlations of the described functions.

#### Research Findings

Groups of male and female volunteers recruited from local college student communities served as experimental subjects in these studies. All subjects received psychometric test evaluation and interview assessment by a staff psychologist as part of the screening procedure for acceptance as participants in the experiments. Each subject was fully informed about the research setting and procedures, which included several daily briefing sessions in the programmed environment preceding the start of an experiment to insure familiarization with the operational features of the laboratory. Following these briefings, but before beginning an experiment, a written informed consent agreement was signed and exchanged between the subjects and experimenters. In addition, a manual of instructions detailing the experimental procedures and environmental resources was provided each subject for guidance throughout the experiment. The subjects in experiment I were three males ages 34, 23, and 21. The subjects in experiment II were three females ages 32, 24, and 29.

In the first experiment, three male subjects lived for 48 consecutive hours in a continuously programmed laboratory environment. During their residence, the subjects could earn money by performing on any of four work tasks that were concurrently available. The four tasks were (1) the Alluisi Performance Battery, (2) serial acquisition task, (3) lever pulling, and (4) physical exercise. Monies earned on these tasks during the odd hours

of the day (e.g., 1 o'clock, 3 o'clock, 5 o'clock, etc.) accumulated in the bank account of the individual responsible for the earnings, while monies earned during the even hours of the day (e.g., 2, 4, 6, etc.) contributed to a group bank account in which each participant held a one-third share. Thus, monies earned by work performance were deposited to one or the other bank account (group or individual) depending upon which hour of the day the work was done. At the end of the experiment, subjects received all the money in their individual account plus one-third of the money in the group account.

In addition to earning money, subjects could lose some of their earnings according to the following rule. Two of the work tasks, the Alluisi program and the serial acquisition problem, were presented via a CRT screen that was displayed continuously during the 48-hour period of the experiment. During the last minute of every hour, however, the display was programmed to turn off and the subjects (any one of the three) were required to report this event and thereby reinstate the display. Failure to detect and correct the dark screen condition (within 1 minute) would result in halving (50% reduction) of the accumulated sum of money in one or the other bank account. Failures for each 1 minute that a dark CRT screen went unreported at the end of even hours of the day resulted in a 50% reduction of the total amount in the group bank account, while failures to report a dark CRT screen at the end of odd hours of the day resulted in a 50% reduction (per minute unreported) in the individual accounts.

Thus, subjects were required to maintain this 48-hour monitoring of the CRT display in order to protect their earnings from any loss. Throughout the experiment subjects could audit the totals in all bank accounts.

The principal experimental questions asked in this experiment were (1) How would the group share the responsibility for maintaining vigilance of the CRT display and thereby avoid any monetary loss? (2) How would individuals apportion their work effort with respect to individual versus group earnings?

Experiment II was identical to Experiment I with the single exception that the subjects in Experiment II were three females.

In Experiment I, the three male subjects cooperated in maintaining a continuous watch of the CRT screen and correctly detected all interruptions of the task display, thereby preventing any monetary loss from either the group or individual bank accounts. This cooperative effort involved a rotating schedule of "on duty" responsibility with each participant serving a 3- to 4-hour on, 6- to 8-hour off cycle.

With respect to earnings, however, all three male subjects exhibited a much greater self-interest rather than group effort, with each subject earning much more money for their respective individual bank accounts than they did for the group bank account. This was accomplished by work efforts being disproportionately distributed in favor of the odd hours of the day. Specifically as shown in Figure 3, Subject (1) earned \$71 for himself versus \$36 for the group, Subject (2) \$65 versus \$23, and Subject (3) \$64 versus \$30. This separation of effort was apparent for Subject (2) as early as

the first few hours of the experiment while for the other two subjects, the significantly greater work effort for individual accounts did not emerge until 20 to 24 hours later. These temporal differences can be seen in Figure 4, which shows the hour-by-hour accumulation of earnings over the course of this experiment.

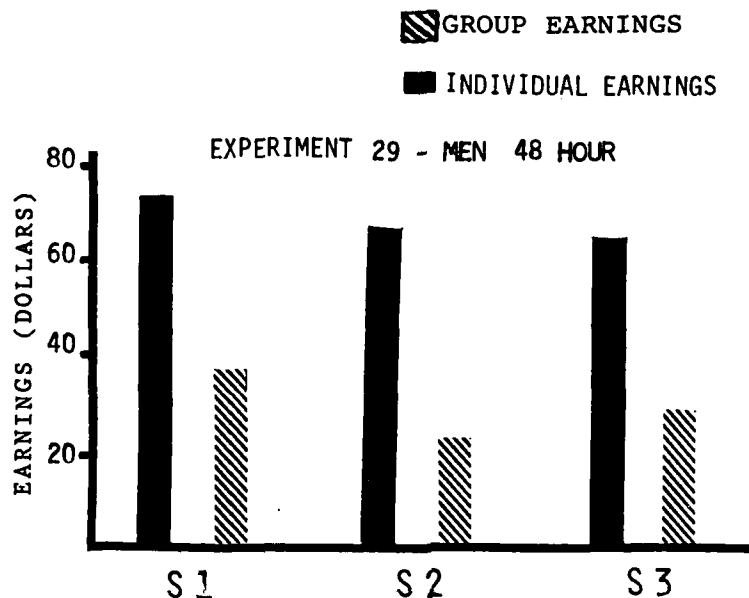


Figure 3. Work efforts disproportionately distributed in favor of the odd hours of the day (for men).

In Experiment II, the three female subjects also maintained a continuous watch of the CRT screen and correctly reported all interruptions of the display. Consequently, as with the male subjects, no money was ever lost from either the group or individual bank accounts. The women's on-off duty cycles were somewhat shorter, however, than the men's with the women averaging 2 to 3 hours on and 4 to 6 hours off. With respect to earnings, two of the female subjects earned approximately equal amounts for the individual and group bank accounts, while the third female subject from the outset showed the self-interested earning pattern of the three male subjects. Specifically as shown in Figure 5, Subject (1) earned \$40 for herself versus \$40 for the group, Subject (2) \$58 versus \$12, and Subject (3) \$41 versus \$36. Figure 6 shows the cumulative record of earnings for the female subjects in this experiment.

Within each group of subjects the following general rule applied: The lower the total earnings (individual + group) the greater was the proportion of earnings for the individual account  $\left( \frac{\text{individual}}{\text{individual} + \text{group}} \right)$ . In both groups of subjects, morale was high, interpersonal relationships were pleasant and during debriefing, all subjects' comments were uniformly positive as they

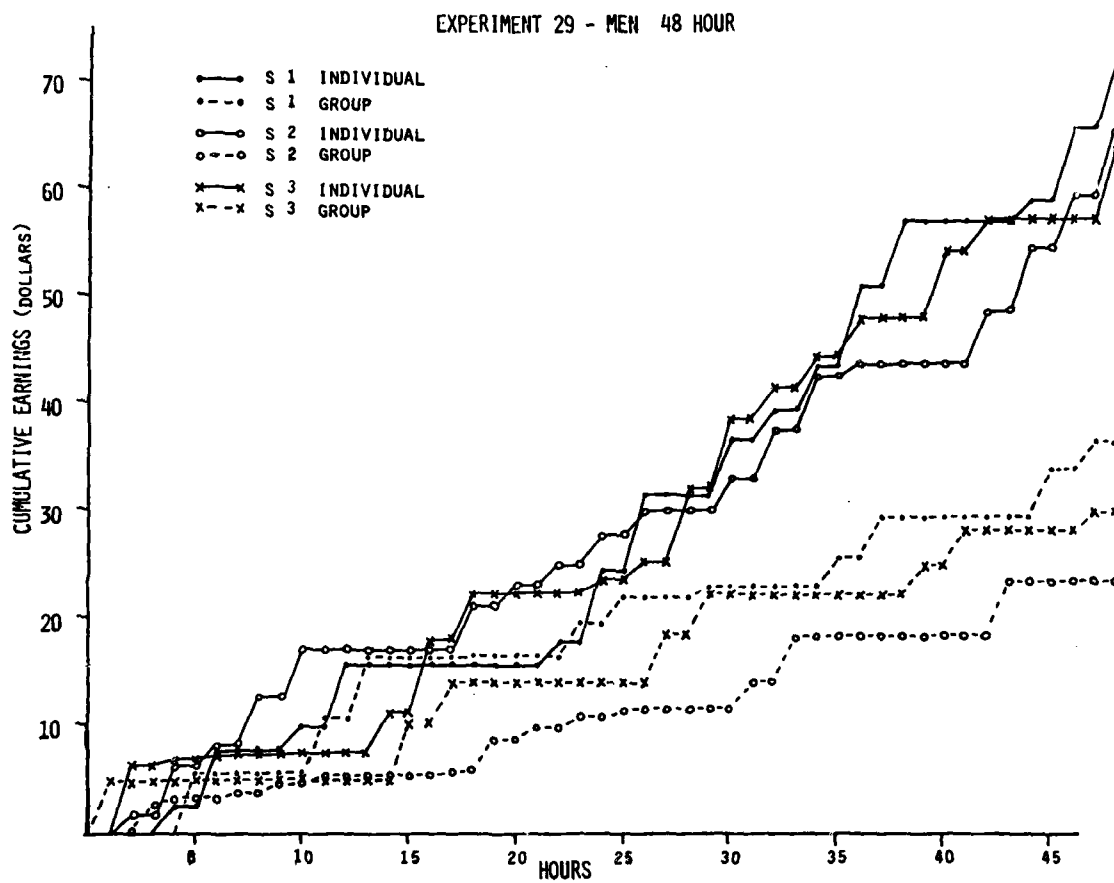


Figure 4. Hourly accumulation of earnings over course of experiment (for men).

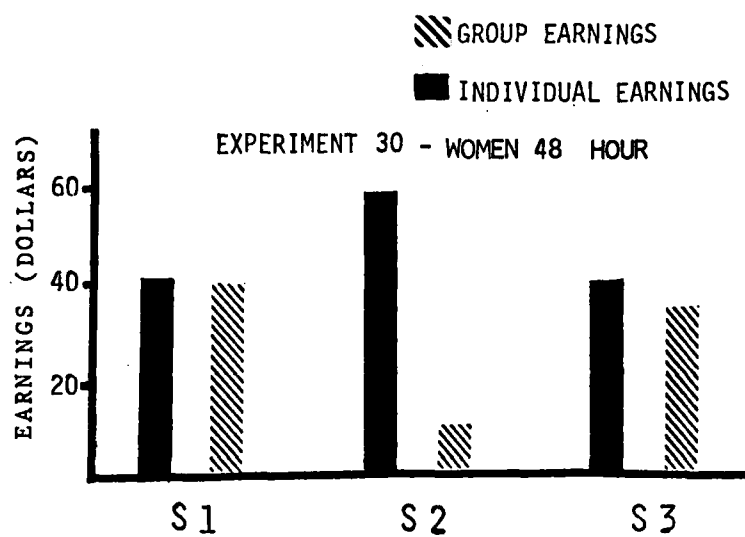


Figure 5. Work efforts disproportionately distributed in favor of the odd hours of the day (for women).

expressed their enjoyment of the experiment and their feelings toward their co-participants.

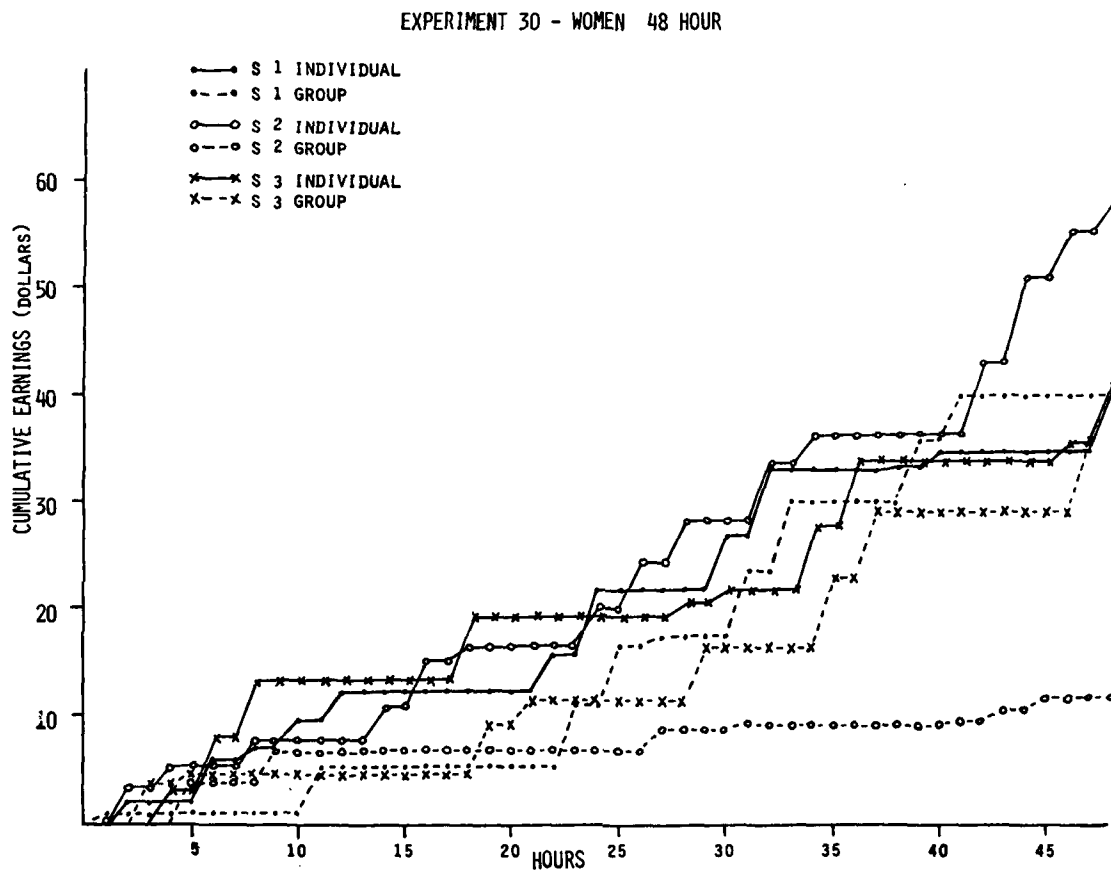


Figure 6. Hourly accumulation of earnings over course of experiment (for women).

In Experiment I, although the men cooperated in maintaining the avoidance of monetary loss, their work efforts were clearly biased toward their personal earnings. By way of explanation, it may be postulated that by working for themselves, earning amounts were "guaranteed" whereas work efforts for the group were proportionately rewarded only if matched by equal work efforts of the other group members. From an individual's point of view, the relative uncertainty of group performance and thereby individual contributions and shares in the group total can be viewed as one reason for this outcome. Furthermore, the early emergence of self-interested performance by one subject can be seen to confirm this potential imbalance for the remaining subjects

and set the example for their performance during the remainder of the experiment.

The outcome of Experiment II, however, revealed that two of three female subjects did not work significantly more for their individual earnings despite the fact that one female worked proportionately even more for herself than did any of the male subjects. These data suggest first that the self-interest outcome of this experimental situation is not inevitable nor does the example set by one individual necessarily serve as a model for emulation by the other participants. Taken together, the data from these experiments suggest a sensitive procedure for revealing self-interest versus group-oriented behavior in a residential laboratory setting. On-going experiments focusing upon such variables as sex, personality, and payoff matrices should clarify the role of these variables in determining the outcome of these socially relevant behavior processes.

Experiment III involved three men living in the experimental environment for 10 consecutive days. During this time the men followed the daily behavioral activity schedule and earned money by performing the Alluisi task between regular program activities. In order to investigate the control exercised by individual versus group pay systems, various days of the experiment were designated either group or individual and money earned on that day went into the appropriate account as in Experiments I and II. Figure 7 shows the frequency and distribution of work episodes for each of the 10 experimental days. After some adaptation on day 1, all three subjects established a very stable work pattern in which each subject worked three times a day, and typically 3 to 4 hours per work episode.

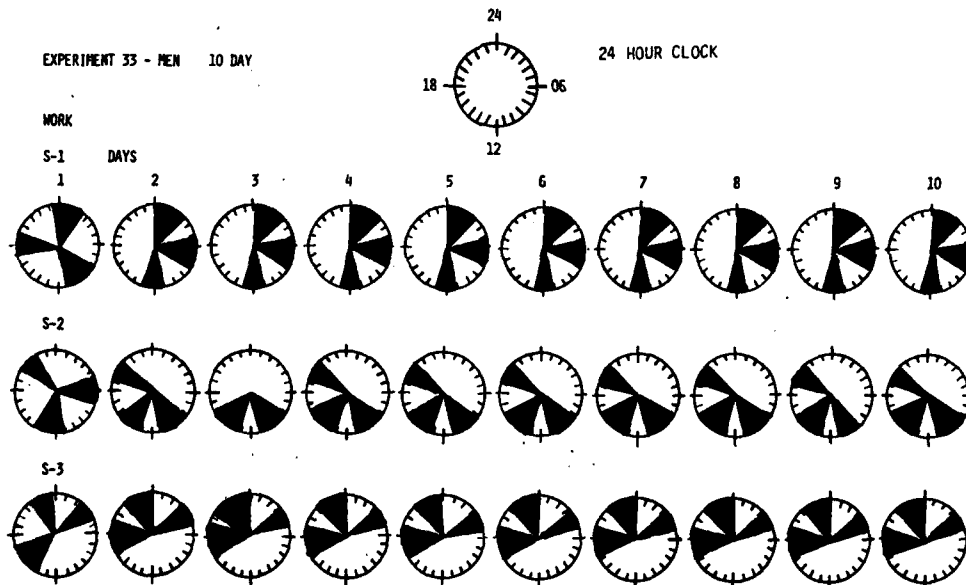


Figure 7. Frequency and distribution of work episodes.



Sleep episodes on the other hand were not as stable as work episodes for Subject (3) although relatively stable for the other two subjects. See Figure 8.

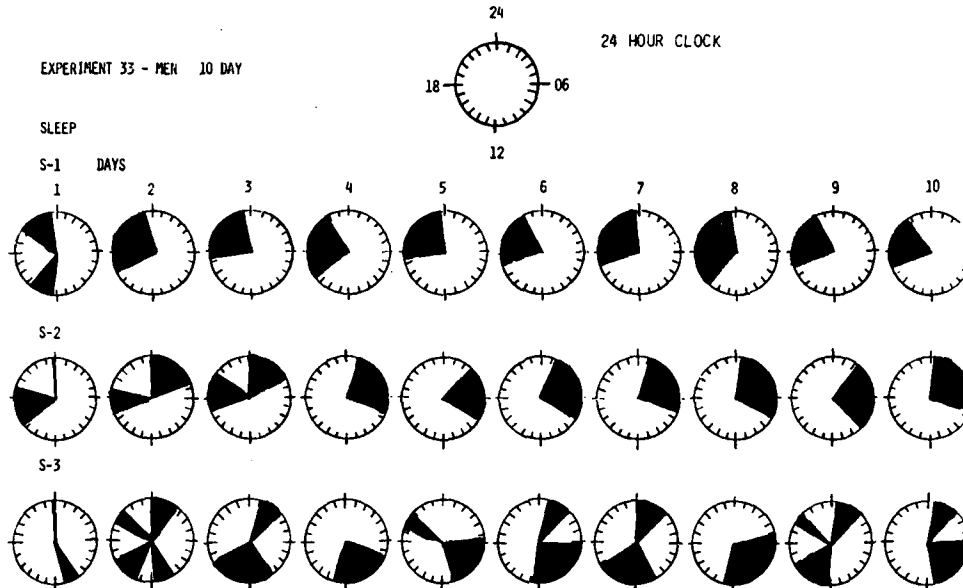


Figure 8. Frequency and distribution of sleep episodes.

With regard to motivational control, the unexpected outcome of this experiment was that daily earnings were relatively stable and insensitive to changes in the form of earnings (i.e., individual versus group bank accounts). See Figure 9. The data from these experiments suggest that conformity to a rule depends not only upon the nature of the rule itself, but also upon its temporal parameters and the extent to which these parameters match or correspond to the temporal size of everyday work and rest activities. Our current hypothesis regarding this outcome is that the effects of such motivational systems are directly influenced by the temporal distribution of daily work and nonwork activities. That is, if the nature of a task is such that hourly segments of work-nonwork cycles naturally occur, then a motivational system (e.g., individual versus group) available on the same temporal scale will be relatively more effective than one which is much longer than the natural alteration of work and nonwork behaviors.

The most recent experiment was concerned with determining the effects of imposed triadic work conditions upon performance effectiveness, social interaction, and morale. Three male subjects spent 10 days in the environment and could earn money either by working on the serial acquisition task (SAT) and/or the biofeedback task. (This study also introduced the first systematic use of the biofeedback task.) For the SAT, subjects earned 25¢ for each correct problem, while for the biofeedback-assisted self-regulation of finger temperature subjects received \$1.00 per degree (F°) that they were

able to change finger temperature. During days 5, 6, and 7, subjects were required to enter and leave the work room only as a group of three. On all other days there was unrestricted entrance to the work room for all subjects, either individually or in groups. In this experiment all monies earned were shared equally through a single group bank account. Earnings were limited to a maximum of \$150 for the group total in any single day. The results of this experiment, as seen in Figure 10, showed that individual contributions to the group account were not equally distributed among the three participants. Subject (1) contributed \$250, Subject (2) \$235, and Subject (3) \$615. Despite this inequity, the group maintained good social relations and achieved the maximum allowable earnings on 7 of the 10 days, including the last 6 days in a row. Figure 11 shows how the three participants grouped themselves in the work room each day over the course of the 10-day experiment. During days 5, 6, and 7, entrance to the work area was only permitted when all three subjects went to work together. Before (days 1 through 4) and after (days 8 through 10) this imposed condition, triadic work episodes were infrequent and of relatively short duration (~1 hour). During days 5 through 7, two triadic work episodes occurred each day, with each lasting for several hours. Figure 12 shows the subjects' use of the social area individually, or in dyadic or triadic groups. Unlike the rules for work episodes there were no constraints or rules governing the use of the social area. It appears, however, that triadic social episodes were markedly influenced by the required triadic work episode. Moreover, superimposition of Figures 11 and 12 reveals that these triadic social episodes regularly occurred at about the same time each day between triadic work episodes. There were few triadic social episodes before the imposition of triadic work conditions, and no further triadic social episodes during the last 3 experimental days when the triadic work restriction was lifted and only one triadic work episode occurred.

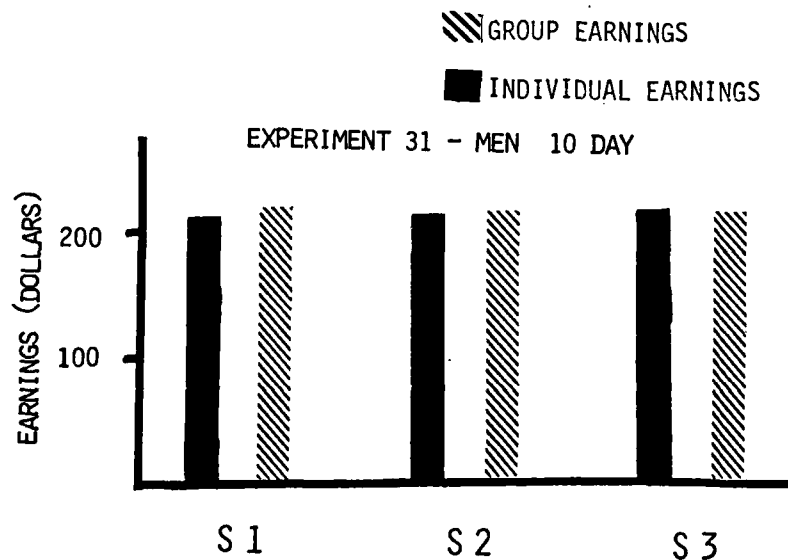


Figure 9. Stability between group and individual earnings.

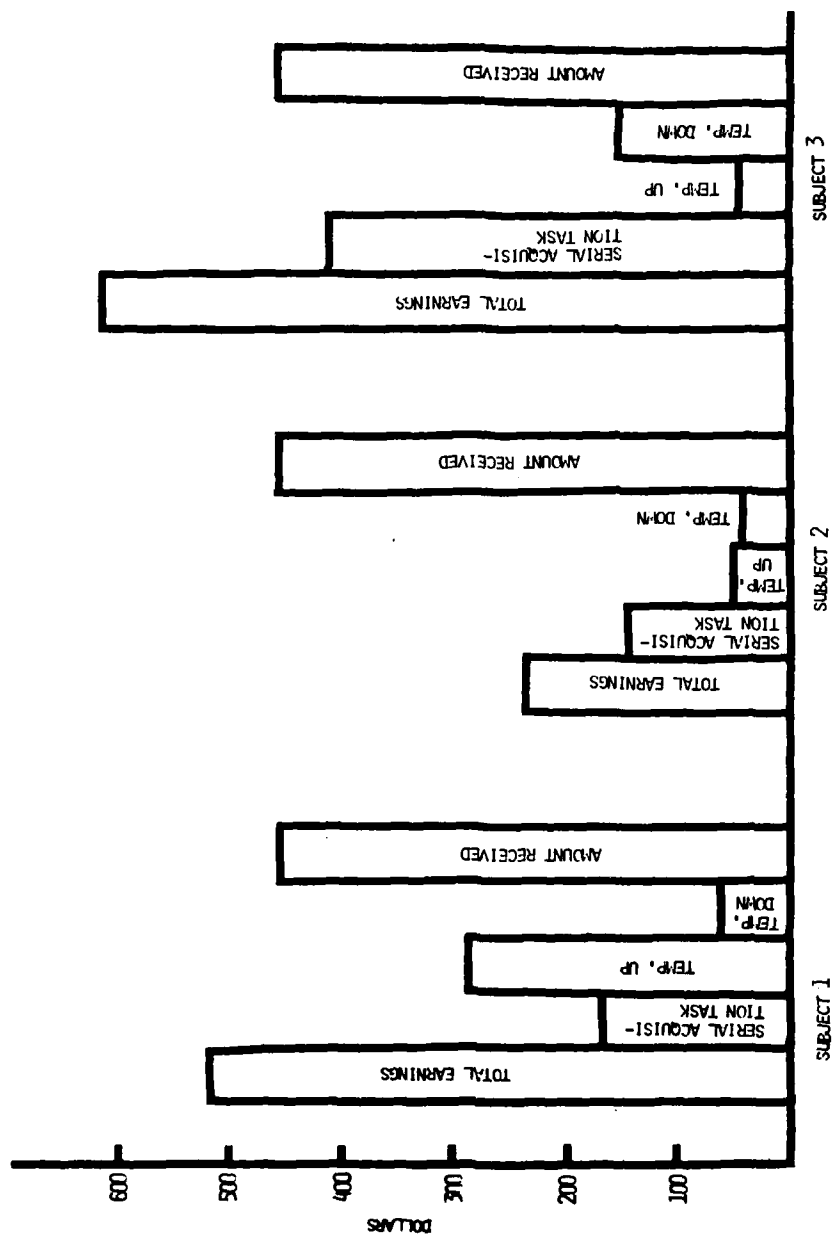


Figure 10. Individual contributions to the group account.

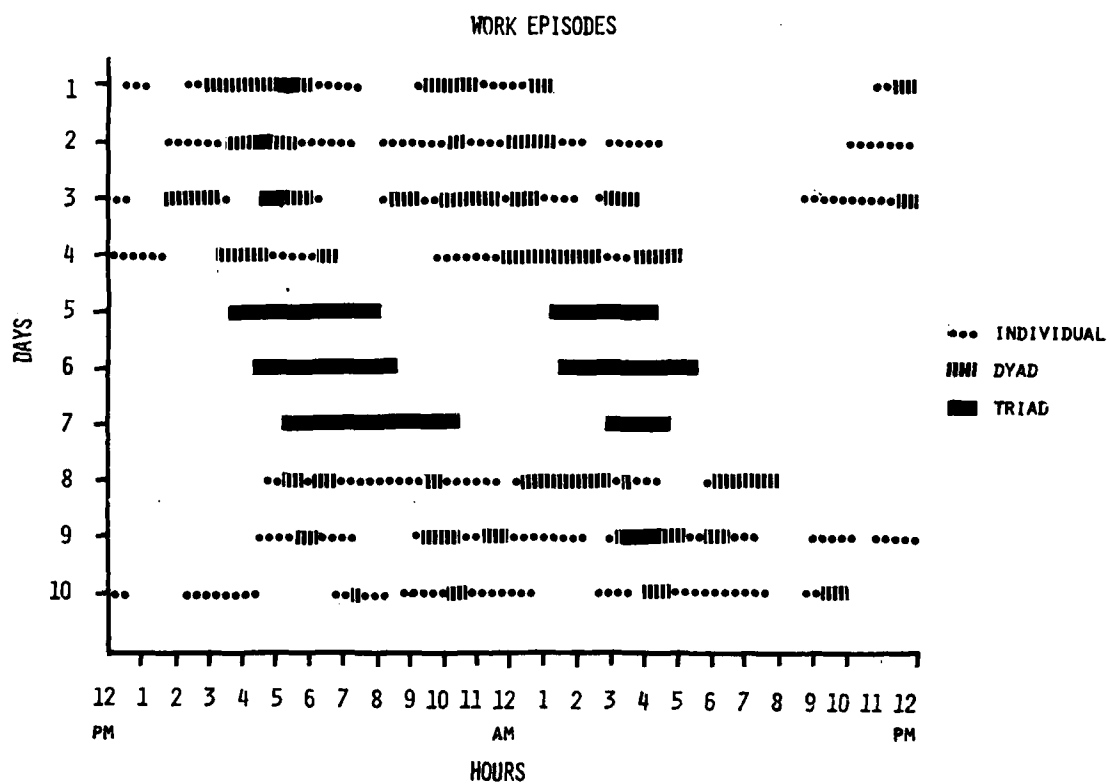


Figure 11. Grouping of three participants in the work room for each day of the 10-day experiment.

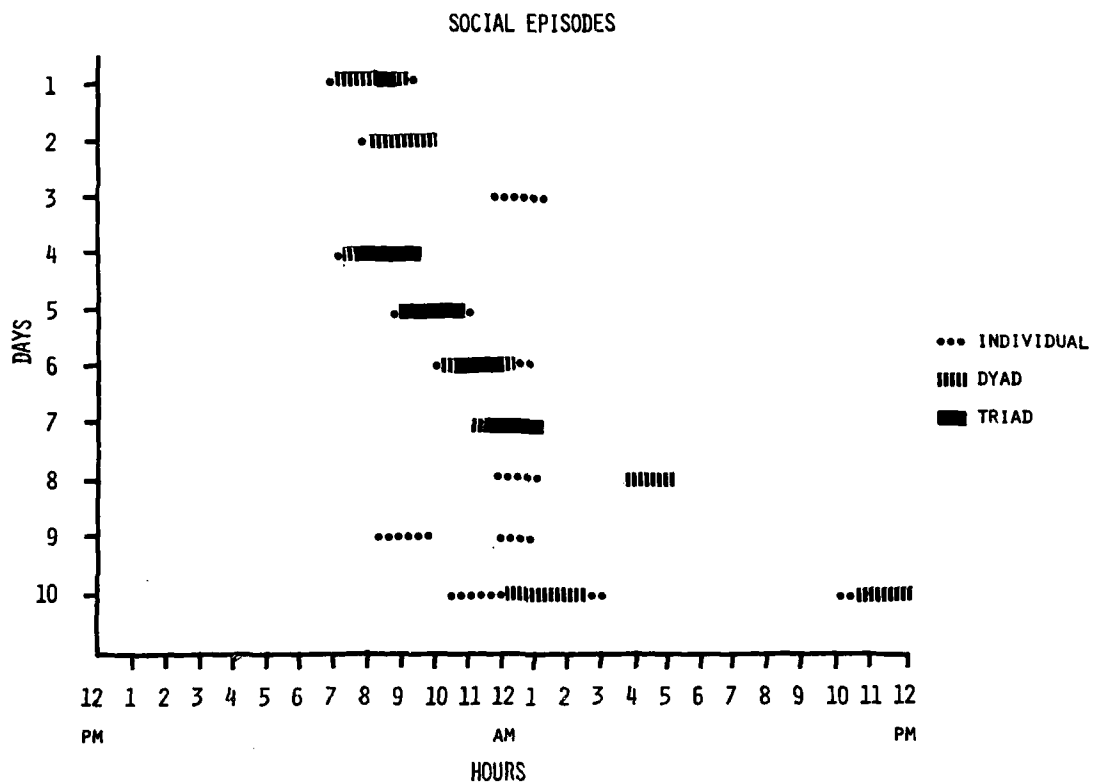


Figure 12. Grouping of three participants in the work room for each hour of the day of the 10-day experiment.

Figures 13, 14, and 15 show the performance of the three subjects on the temperature self-regulation task. Several findings regarding this performance task are noteworthy especially since this represents the first use of this procedure as a regular part of the work performance battery. These findings may be summarized as follows:

1. Subjects made frequent use of the temperature self-regulation task, with each subject working on this task at least once a day during each of the 10 experimental days.
2. All subjects showed some degree of ability to control finger temperature, with Subject (1) showing this ability to a remarkable extent.

Subjects typically reported enjoyment and/or relaxation, as well as personal satisfaction in achieving some degree of mastery over their own bodily functions.

As indicated, there were substantial intersubject differences in temperature control performance. Subject (1) showed the largest amount and use of temporal self-regulation which was confined almost exclusively to temperature raising during the first 6 days and then during the last 4 days, included about equal amounts of raising and lowering sessions. Throughout the 10 days, however, the extent of temperature raising was consistently greater than that of temperature lowering. Subjects (2) and (3) showed temperature control to a lesser extent with more equal use of temperature raising and lowering modalities.

In following up the results of these experiments, future research will address the following questions:

1. How does the temporal duration of work and rest schedules interact with individual versus group-oriented motivations?
2. How do organizational work arrangements interact with and influence social interactions and team cohesiveness as well as group productivity?
3. How does biofeedback-assisted temperature self-regulation interact with social and work performances?

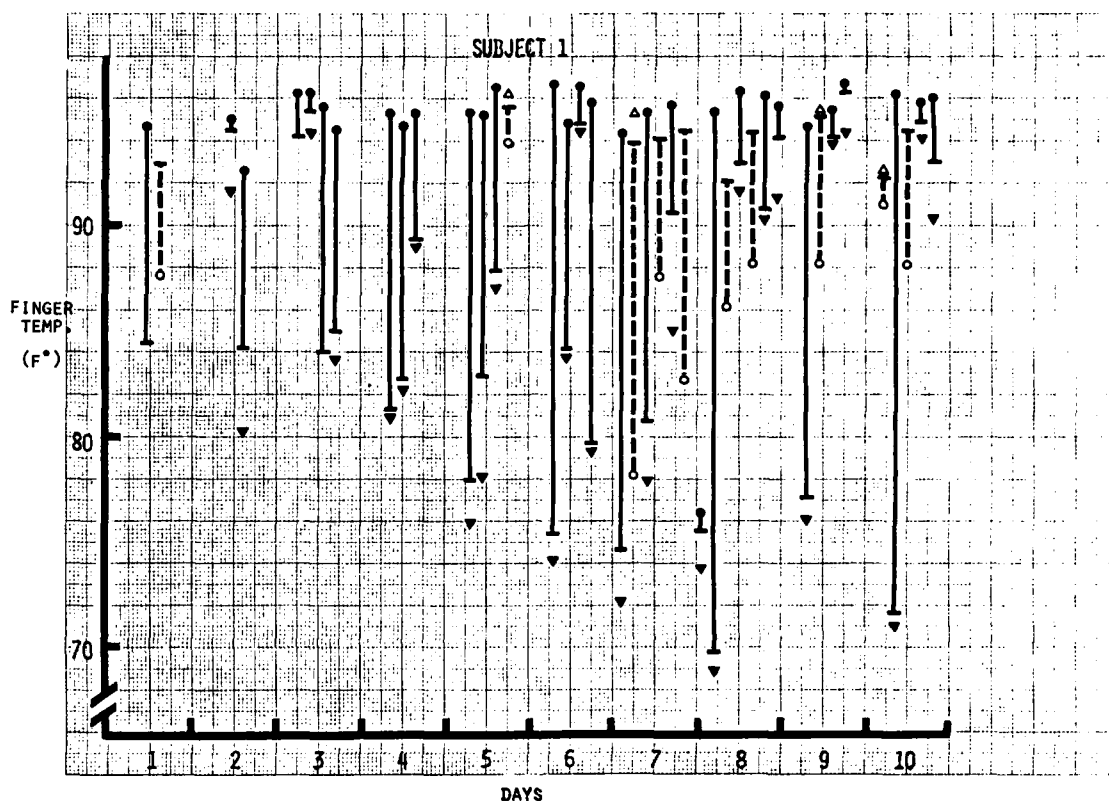


Figure 13. Subject (1) performance on the temperature self-regulation task. Temperature control performance for Subject (1) over successive days of the experiment. Each short horizontal line (-) represents the starting temperature and each o or • represents the highest or lowest temperature achieved during sessions of temperature raising (•) or temperature lowering (o). Each triangle represents the other extreme temperature recorded for that session when it was not included in the range of temperatures covered by the solid (—) or dashed lines (---) for temperature raising or lowering, respectively.

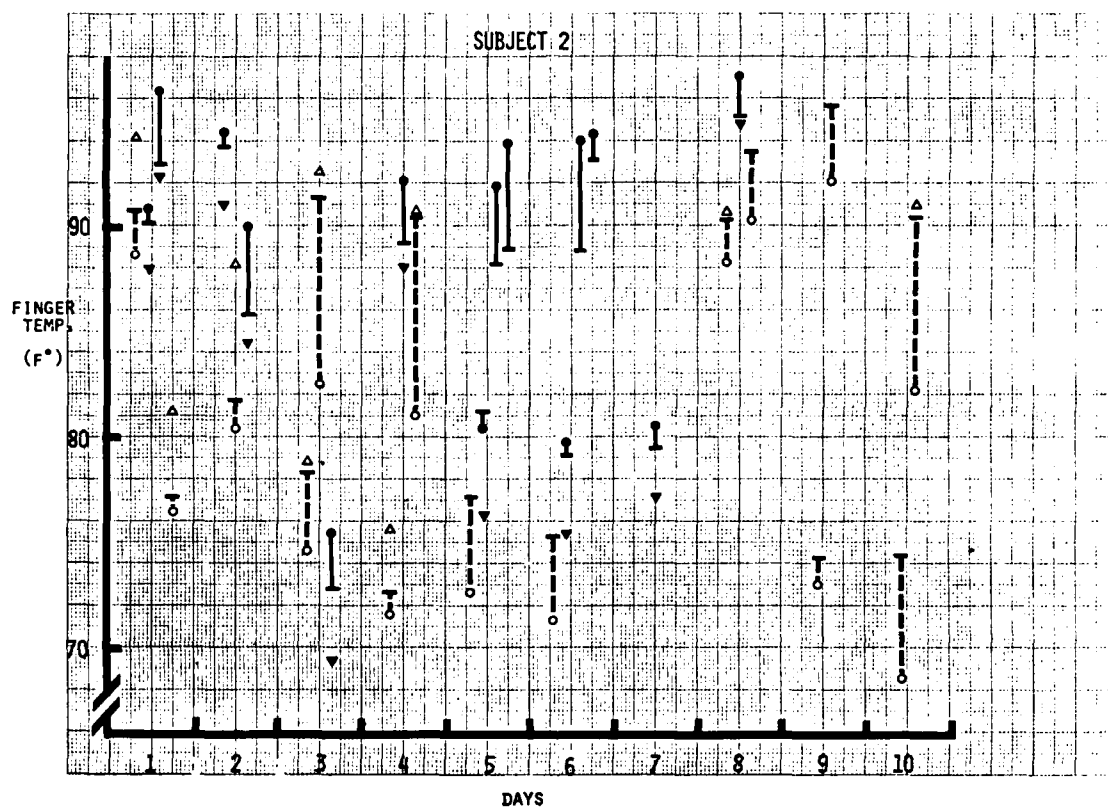


Figure 14. Subject (2) performance on the temperature self-regulation task.



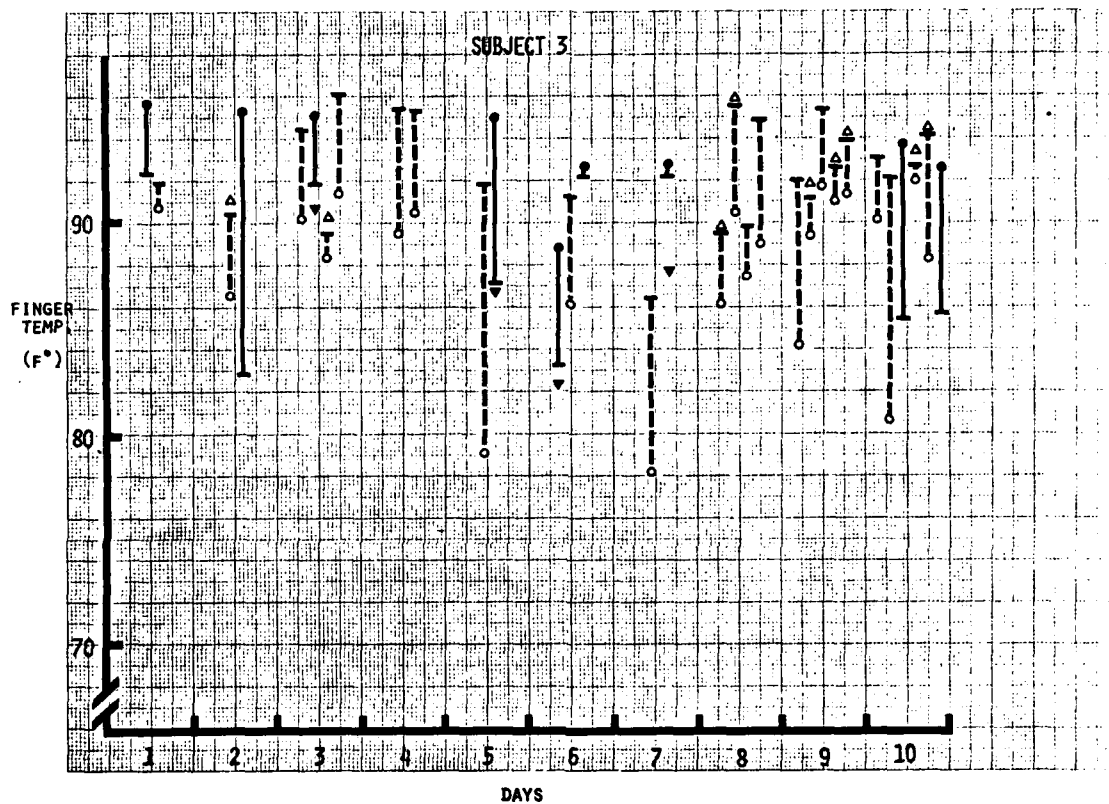


Figure 15. Subject (3) performance on the temperature self-regulation task.

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